| | Separation of Wanted and Interfering Signal (MHz) | | Interference Level (Carrier/Interference (dB)) | |
|---|---|---|---|---|
| Video Baseband | Co-polar | Cross-polar | Co-polar | Cross-polar |
| <3.5 MHz | 28 | 14 | 0 | 28 |
| <6 MHz | 56 | 28 | 0 | 28 |
| <10 MHz | 56 | 28 | 0 | 28 |
| <14 MHz | 56 | 28 | 0 | 28 |

***Note:**The Cross-polar specifications above do not apply to 38 GHz.*

Table 2.6: Adjacent channel separation and interference levels for bands up to 38 GHz

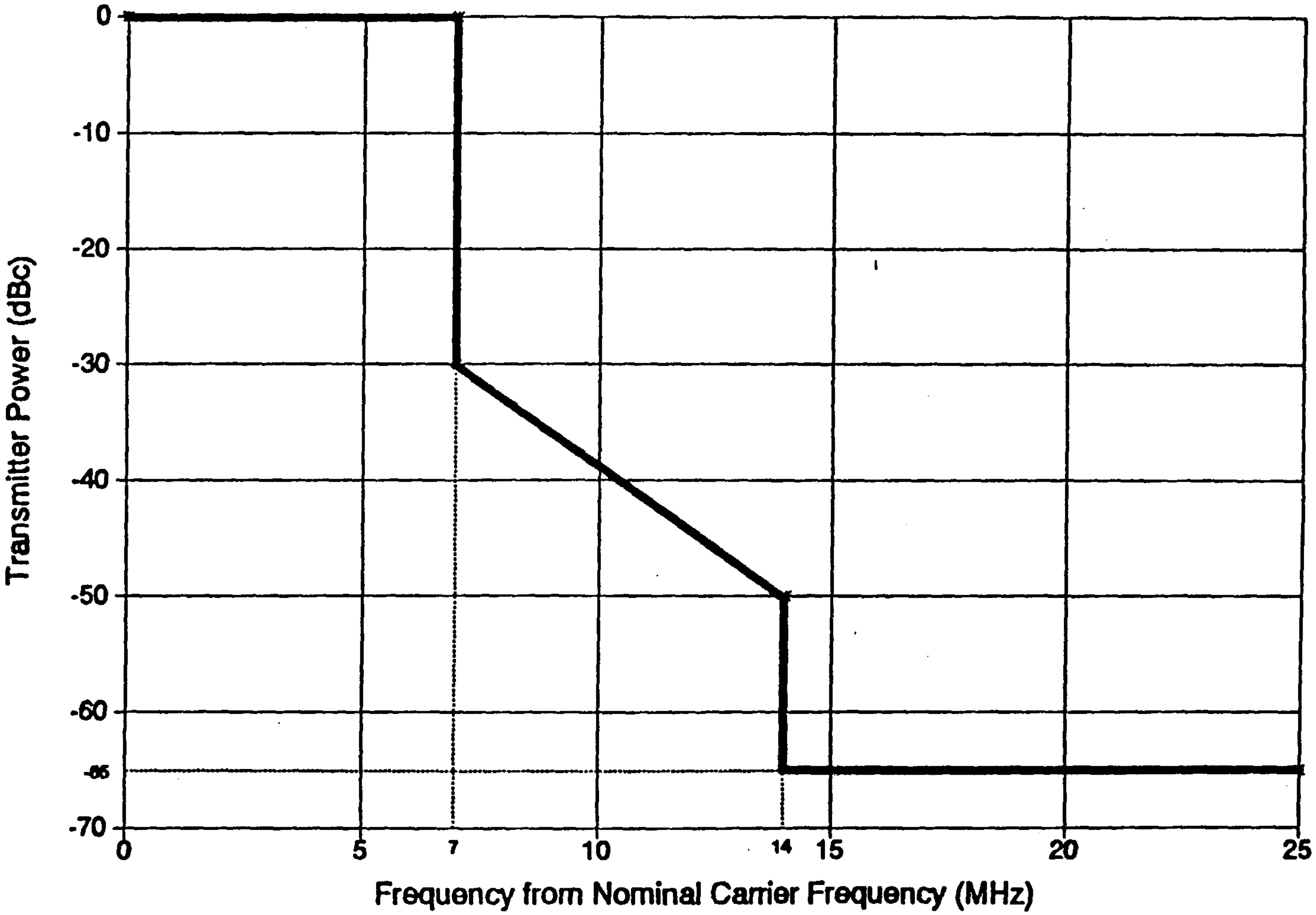
3.2.2.3 CW spurious interference

For a receiver operating with a 'WANTED' signal whose level is 9dB above the receiver threshold as defined in 3.2.1 above, the introduction at point C of a CW interferer at a level of +30 dB with respect to the 'WANTED' signal and at any frequency from the lowest I.F. frequency to twice the highest Receiver input frequency, excluding frequencies either side of the wanted signal by up to twice the relevant co-polar spacing, shall not result in a degradation of any output signal/noise of more than 1dB.

FIG 2.4A LIMITS OF SPECTRAL POWER DENSITY FOR VIDEO BASEBANDS UP TO 3.5 MHZ

## Fig 2.4A Limits of Spectral Power Density for Video Basebands up to 3.5 MHz

Referred to Nominal Centre Frequency (fo)

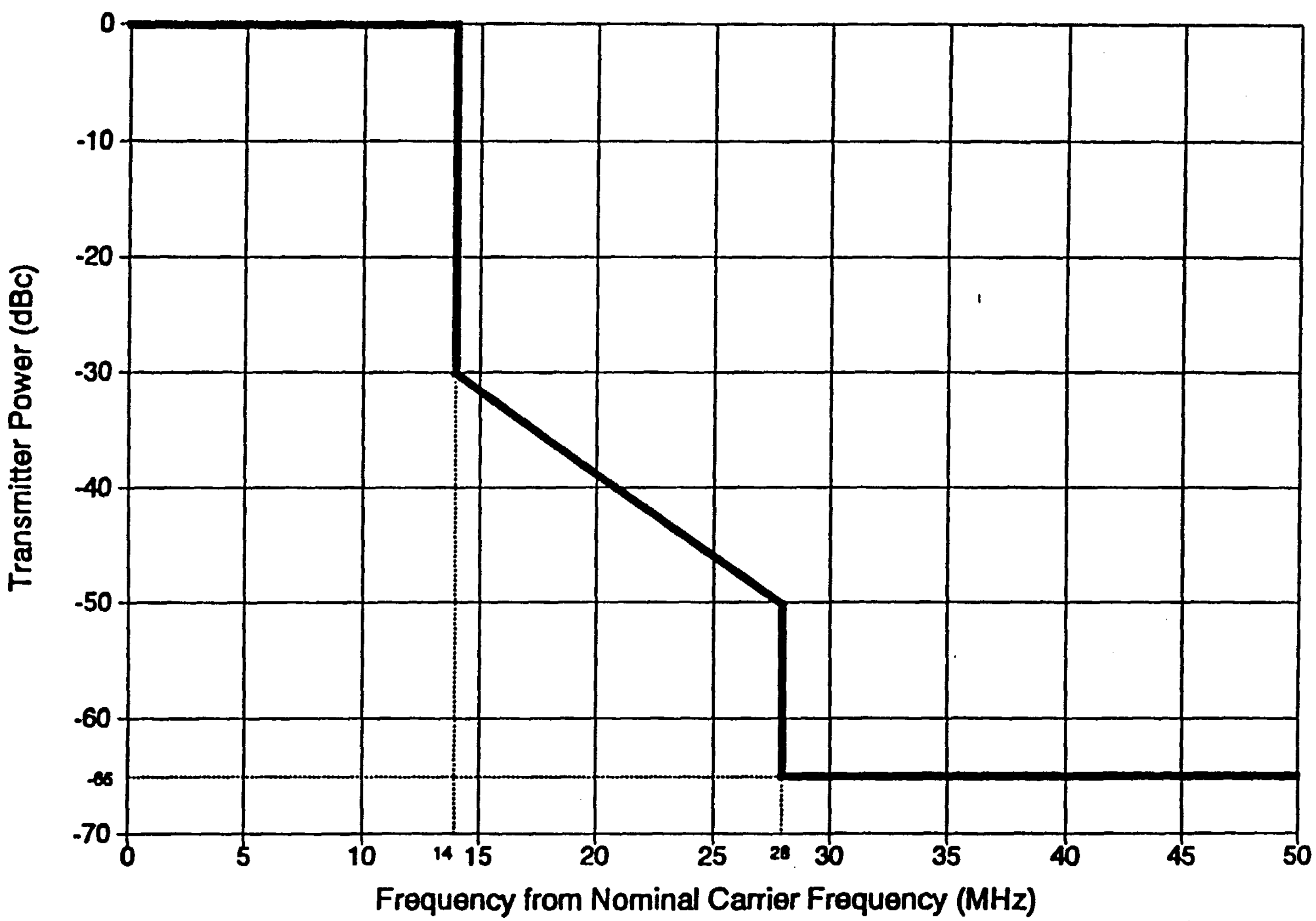



(Mask includes an allowance for Frequency Tolerance)

FIG 2.4B LIMITS OF SPECTRAL POWER DENSITY FOR VIDEO BASEBANDS UP TO 14 MHZ

# Fig 2.4B Limits of Spectral Power Density for Video Basebands up to 14 MHz

## Referred to Nominal Centre Frequency (fo)




(Mask Includes an allowance for Frequency Tolerance)

## APPENDIX A. CALCULATION OF NOISE BUDGETS

The maximum allowable interfering level is that which, when added to the receiver thermal noise, increases the noise by 1 dB. The interfering level is calculated as follows:

$$InterferingLevel = ReceiverNoise - 6\,dB$$

i.e.

$$InterferingLevel = KTBF - 6\,dB$$

Tables A.1 shows the calculations for all video basebands referred to in this specification.

| | Video Baseband | | |
|---|---|---|---|
| | 28 GHz Band | | |
| | < 3.5 MHz | < 10 MHz | < 14 MHz |
| Thermal noise, KT(dBW/Hz) | -204 | -204 | -204 |
| Rx bandwidth, B (dBHz)- | 72 | 75 | 76 |
| Noise Figure, F (dB) | 12 | 12 | 12 |
| Receiver noise (dBW) (K + B + F) | -120 | -117 | -116 |
| Interfering level(dBW) (KTBF - 6 dB) | -126 | -123 | -122 |

**Table A.1 Noise Budget and Interference Calculations.**

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## PART 3

Antennas for Private Fixed Radio Services Operating in
the Frequency Band 27.5 GHz to 29.5 GHz.

# CONTENTS

# 1 GENERAL

## 1.1 Scope of Specification

This specification covers the minimum performance requirements for vertically polarised antennas to be used in the band 27.5 GHz to 29.5 GHz allocated to Public Telecommunications Operators and private fixed radio services. Two types of antennas are included, a directional and an omnidirectional type. The directional antennas are further classified into standard and high-performance versions. High performance antennas may be specified by the license applicant, in preference to Standard antennas, but may also be required by the Licensing Authority in cases which require improved spectrum efficiency.

## 1.2 Licensee's Responsibility

The installation of equipment, either fixed or mobile, is subject to the issue of a licence by the Secretary of State. Under the conditions of the licence it will be the responsibility of the licensee to ensure that the equipment provided conforms with and is maintained to the requirements of this specification. The requirement in this case is that the antenna shall be type-approved.

## 1.3 Labelling

Complete antenna assemblies shall be clearly identified with a weatherproof and permanent mark (or marks) showing the manufacturer's name and type number. Additionally the antenna shall display a mark indicating the orientation required to achieve vertical polarisation. Each antenna shall have a permanent label giving the value of the gain and the antenna type declared in 1.4.

## 1.4 Declarations

When submitting an antenna for type approval the manufacturer shall supply the following:-

(a) the type of antenna, ie directional or omnidirectional and in the case of a directional antenna, the category standard or high performance.

(b) the nominal antenna gain.

## 1.5 Test Arrangements

All performance testing of antennas will be carried out at a test site specified by the testing authority. Testing shall be carried out on dry antennas.

NOTE: Radomes shall be fabricated from hydrophobic materials to minimise the effect of water droplets on the radiation pattern. Testing of wet antennas is under consideration.Arrangements will be made for the applicant to deliver his antenna to the test site at least two weeks before testing is scheduled to begin.

Manufacturers may be required to participate in the mounting and dismantling of the antenna. Applicants will normally be expected to make arrangements to remove their antennas from the test site within 14 days of receiving notification from the testing authority that tests have been completed.

NOTE: Tests may from time to time be cancelled postponed at short notice due to unsuitable weather conditions.

### 1.6 Polarisation

The polarisation of radiation shall be within 5 degrees of the appropriate polarisation direction.

### 1.7 Offshore Environment

Antennas to be used offshore shall additionally meet the environmental requirements of Chapter 2 of Radiocommunications Agency specification MPT 1405.

### 1.8 Interpretation of this Specification

In case of doubt about the interpretation of this specification the decision of the testing authority shall be final.

### 1.9 Testing Authority

The testing authority shall be Radiocommunications Agency or one approved by the Agency.

## 2 TECHNICAL REQUIREMENTS

### 2.1 Definitions

**Radiation pattern** — A diagram relating power flux density or field strength at a constant distance from an antenna to the direction relative to the antenna main beam. The distance is required to be greater than the minimum far-field distance of the larger of the antenna under test or the reference antenna used for the radiation pattern measurement. The minimum far-field distance is given by the following formula:

$$\textit{Minimum far-field distance} = 6.7D^2F \textit{ Metres}$$

where: D is the aperture diameter of the larger of the antenna under test or the reference antenna, expressed in metres.
F is the frequency in GHz.

**Radome** — A cover for an antenna system which is weatherproof and intended to be transparent to radio frequency energy.

**Co-polar pattern** — A diagram representing the radiation pattern of a test antenna when the reference antenna is similarly polarised, scaled in dBi or dB relative to the measured antenna gain.

**Beam axis** — The direction, within the major (main) lobe of a narrow beam antenna, for which the radiation intensity is a maximum.

**Major/Main lobe** — The radiation lobe containing the direction of maximum radiation.

**Beam of an antenna** — The major (main) lobe of the radiation pattern of an antenna.

Antenna gain — The ratio of power measured in the boresight direction to the level that would exist if the radiated energy (if the test antenna was considered to be in transmit mode) was uniformly distributed over a sphere centred on the test antenna, ie., an isotropic radiator radiating the same power as the test antenna. The antenna gain is expressed in dB above isotropic level and is denoted by dBi.

## 2.2 Directional Antenna

This section describes the approval test requirements, method of measurement and specification limits for the directional standard and high-performance antennas.

### 2.2.1 Approval Test Requirements

Approval tests will be conducted on the following antenna performance parameters:

(a) Gain

(b) Radiation Pattern

The values measured during the approval tests shall meet the limits outlined in Section 2.2.3, below.

### 2.2.2 Method of Measurement

Measurements shall be made at the test frequencies 27.5 GHz, 28.5 GHz and 29.5 GHz. The testing authority reserves the right to test at additional frequencies within the frequency range 27.5 GHz to 29.5 GHz should it be deemed necessary. If the antenna is designed for use with a radome or feed shroud, then measurements shall be made with this in place.

(a) Gain

The method of gain measurement shall be proposed to and agreed with the testing authority at least 2 weeks prior to the approval test.

(b) Radiation Pattern

The co-polar pattern shall be measured and plotted at each test frequency with the antenna polarised in the vertical plane.

### 2.2.3 Specification Limits

(a) Gain

The measured antenna gain shall meet the minimum requirements specified in Table 3.1 and be within ±2 dB of the value declared in 1.4.

TABLE 3.1 ANTENNA GAIN

| Antenna Type | Gain dBi min |
|---|---|
| Standard | 32 |
| High Performance | 32 |

(b) Radiation Pattern

The values of the gain of the measured co-polar pattern of the antenna shall be equal to or less than the values given in Figures 3.1 and 3.2.

## 2.3 Omnidirectional Antenna

This section describes the approval test requirements, method of measurement and specification limits for the omnidirectional antenna.

### 2.3.1 Approval Test Requirements

Approval tests will be conducted on the following antenna performance parameters:

(a) Gain

(b) Radiation Pattern

The values measured during the approval tests will meet the limits outlined in Clause 2.3.3 below.

### 2.3.2 Method of Measurement

Measurements shall be made at the test frequencies 27.5 GHz, 28.5 GHz and 29.5 GHz. The testing authority reserves the right to test at additional frequencies within the frequency range 27.5 GHz to 29.5 GHz should it be deemed necessary. If the antenna is designed for use with a radome or feed shroud, then measurements shall be made with this in place.

(a) Gain

The antenna gain will be measured using the gain by comparison technique in which the gain of the antenna under test is compared with that of a calibrated gain antenna typically a standard gain horn. In practice this will involve comparing the peak received power level of the omnidirectional antenna with the peak (boresight) level received from the standard gain horn. The particular azimuthal pointing angle of the omnidirectional antenna shall be noted. The antenna is mounted at 0° elevation. The comparison shall also be made at three other positions separated from the noted azimuth position by 90, 180 and 270 degrees. The gain is the average value of the four measurements at each frequency.

(b) Radiation Pattern

The radiation pattern response shall be demonstrated on a far field test range, in the azimuth and elevation planes. The co-polar patterns are measured at the test frequencies referred to above. Azimuth patterns will be recorded by mounting the antenna in its normal orientation (0° elevation) onto a single axis positioner. The antenna shall be rotated about the positioner local vertical axis between -180 and +180 degrees; the signal level received from a fixed power output source shall be recorded as a function of angle.

Elevation patterns are measured by mounting the antenna at 90 degrees to its normal attitude and rotating about the positioner local vertical axis between -90 and +90 degrees. The received signal level shall be then recorded as a function of angle. The elevation patterns shall be measured at four different antenna azimuthal angle settings, typically spaced by 90 degrees.

2.3.3 Specification Limits

(a) Gain

The measured gain of the antenna shall be within ±2 dB of the value declared in Section 1.4.

(b) Radiation Pattern

The measured azimuth co-polar pattern of the antenna shall be within ±3 dB of the gain measured in 2.3.2(a).

The values of the gain of the measured elevation co-polar patterns of the antenna shall be equal to or less than the values given in Figure 3.3.

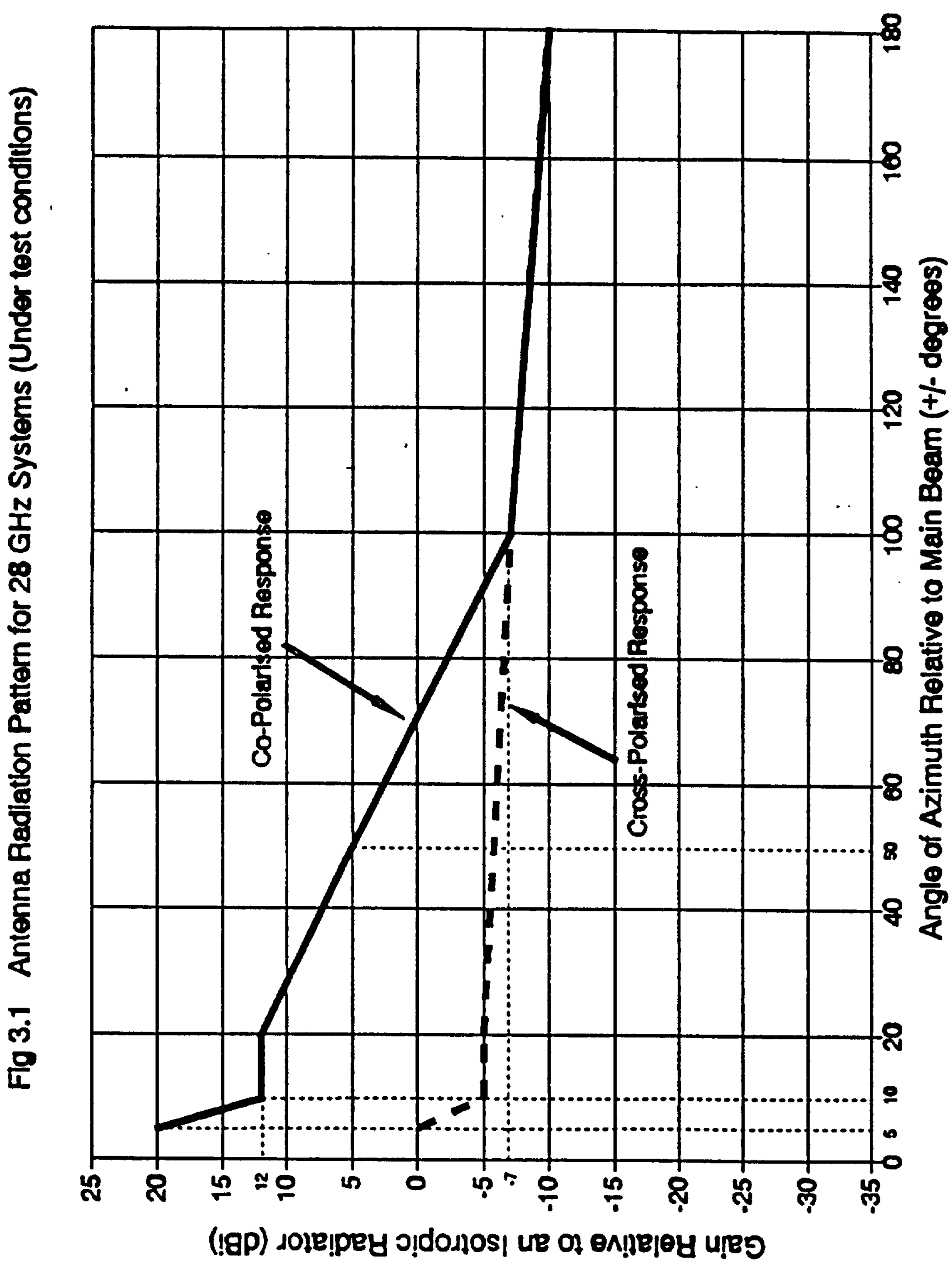
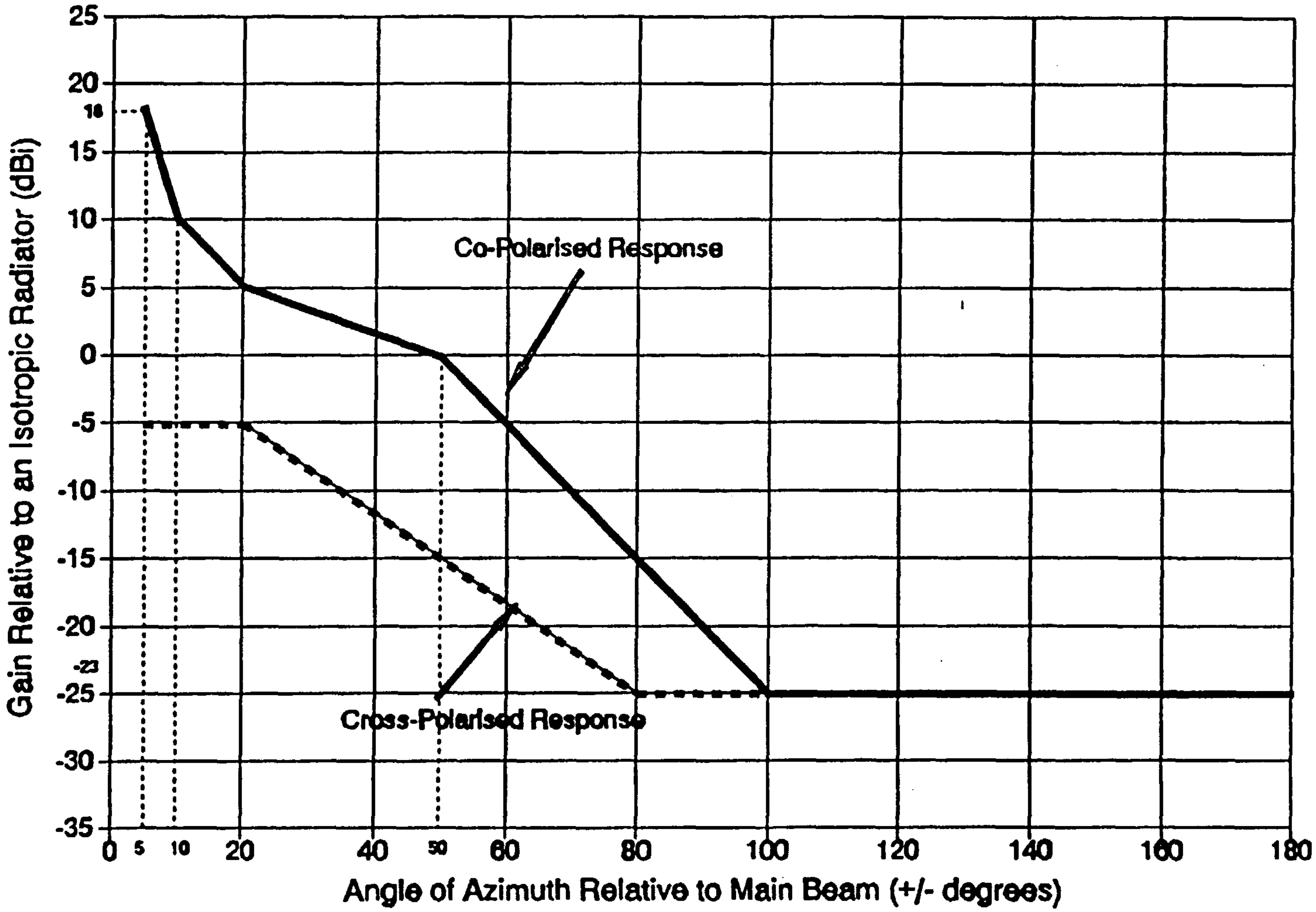



Fig 3.1 Limits of Antenna Gain for Angles Greater than 5° from the Main Beam Axis for the High Performance Antenna

Fig 3.2 Limits of Antenna Gain for Angles Greater than 5° from the Main Beam Axis for the Standard Antenna

## Fig 3.2 Antenna Radiation Pattern for 28 GHz Systems (Under test conditions)



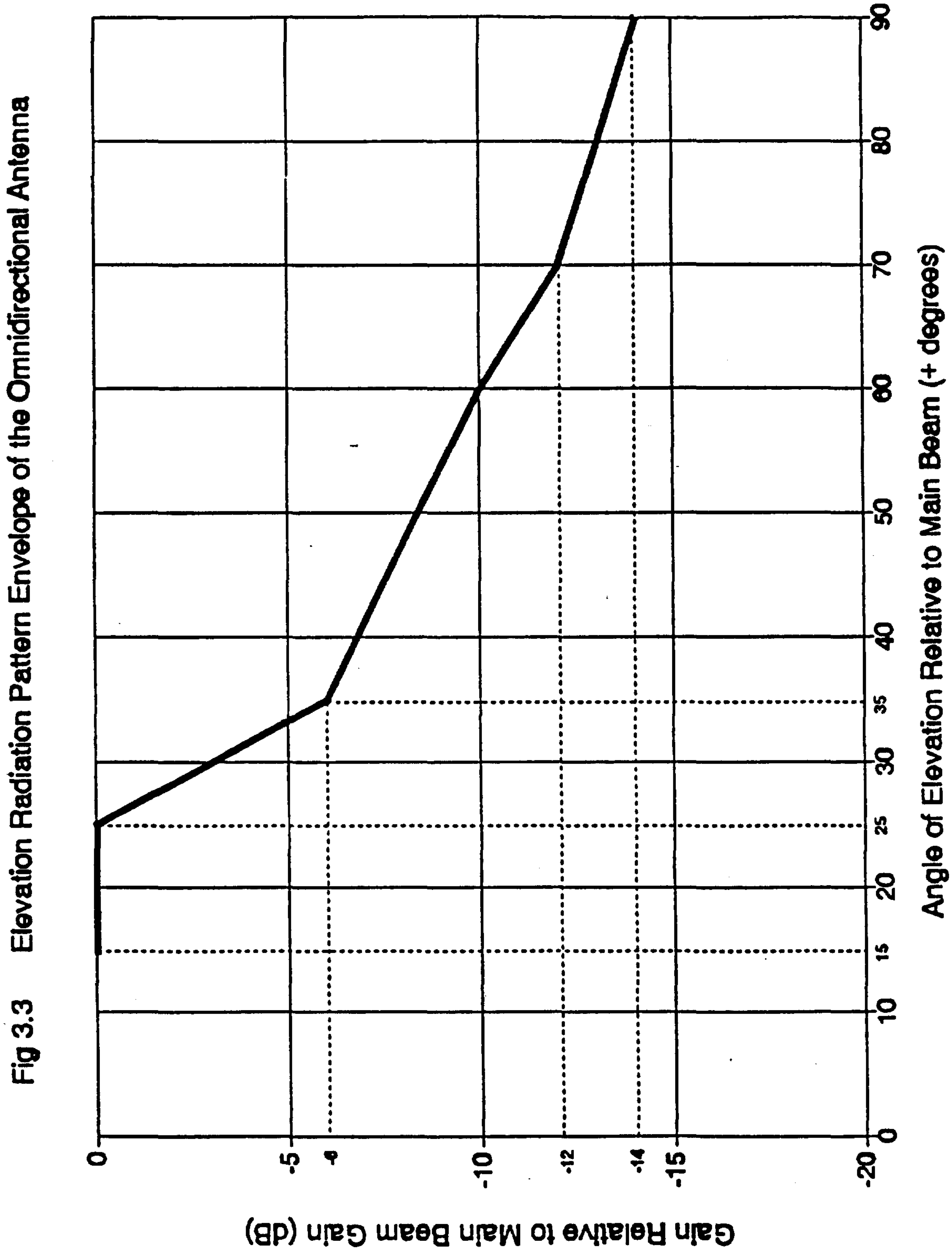



Fig 3.3 Elevation Radiation Pattern Envelope of the Omnidirectional Antenna

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# PART 4

Frequency Assignment Criteria for services operating in the Frequency Band

27.5 to 29.5 GHz.

## CONTENTS

## 1 GENERAL

### 1.1 Introduction

This section outlines the frequency assignment criteria and principles that will be employed in the selection of frequencies for use by all fixed radio services operating in the band 27.5 GHz to 29.5 GHz.

### 1.2 Licensee's responsibility

The establishment, use or installation of transmitting or receiving apparatus is subject to the issue of a licence by the Secretary of State for Trade and Industry. The licensee must ensure that equipment conforms with and is maintained to the standard set out in Parts 1 and 2 of this publication. Licences will only be granted for equipment which has been type approved.

## 2 TRANSMITTING AND RECEIVING INSTALLATIONS

### 2.1 General

The transmitting and receiving installations shall conform to 2.2 and 2.3 below. The installations shall be in accordance with good engineering practice.

### 2.2 Antenna directivity and polarization

At the present time, RA will only consider vertically polarized antennas. The co-polarized directivity of the antenna installed at licensed premises shall be such that the equivalent isotropic gain in the horizontal plane at any azimuth does not exceed the value specified in Part 2 of this specification. The type of antenna specified in Part 2 will be dependent upon the required EIRP and the type of service. High performance antennas may be specified by the license applicant, in preference to Standard antennas, but may also be required by the Licensing Authority in cases which require improved spectrum efficiency, such as geographical areas of congestion, or dense urban areas.

The polarization shall be set within 3° of the vertical.

### 2.3 Equivalent isotropic radiated power (EIRP)

EIRPs will be assigned in accordance with the frequency assignment criteria laid down in this specification. The EIRP is to be set within ±3 dB of the assigned value. In no circumstances shall the EIRP exceed 100 kW (50 dBW).

## 3 PRINCIPLES OF ASSIGNMENT

3.1 A normal frequency assignment for a single both-way link shall comprise a pair of radio frequencies of corresponding number, one from each of the low and high frequency groups.

3.2 The frequency difference between a pair of corresponding go and return frequencies shall be 1260 MHz.

3.3 The frequency separations for like-capacity systems are given in Table 4.1.

**Table 4.1: Channel Separation**

| Type of Modulation | Minimum Capacity | Fig. | Min Co-polar separation between carriers |
|---|---|---|---|
| Digital | 2 Mbit/s | 2.3A | 3.5 MHz |
| | 2 x 2 Mbit/s | 2.3B | 3.5 MHz |
| | 8 Mbit/s | 2.3C | 7 MHz |
| | 2 x 8 Mbit/s | 2.3D | 14 MHz |
| | 34 Mbit/s | 2.3E | 28 MHz |
| | 140/155 Mbit/s | 2.3F | 112 MHz |
| Television and radar remoting with frequency modulation of the carrier | 625 lines and video baseband up to 14 MHz | 2.4B | 56 MHz |
| Surveillance TV | Video baseband up to 3.5 MHz | 2.4A | 28 MHz |

3.4 In assigning frequencies for links which are in the same geographical area due consideration shall be taken of the discrimination of the antennas, referring to Part 2 of this specification.

3.5 It will usually be assumed that each hop has a clearance of 0.577F between the transmitting and receiving antennas at the two stations under conditions corresponding to values of the ratio K greater than 0.7.

F : 1st Fresnel Zone Clearance

K : Effective earth radius to real earth radius

**Table 4.2: Receiver Input Levels**

| Type of Modulation | Capacity | Fig. | Input Level |
|---|---|---|---|
| Digital | 2 Mbit/s | 2.3A | -108 dBW + M |
| | 2 x 2 Mbit/s | 2.3B | -105 dBW + M |
| | 8 Mbit/s | 2.3C | -102 dBW + M |
| | 2 x 8 Mbit/s | 2.3D | -102 dBW + M |
| | 34 Mbit/s | 2.3E | -99 dBW + M |
| | 140/155 Mbit/s | 2.3F | -93 dBW + M |
| Television with frequency modulation of the carrier | 625 lines and video baseband up to 14 MHz | 2.4B | -85 dBW + M |
| Radar remoting | Video baseband up to 14 MHz | 2.4B | -84 dBW + M |
| Surveillance TV | Video baseband up to 3.5 MHz | 2.4A | -98 dBW + M |

Note: 1 A minimum fade margin of 10 dB will be allowed.
2 In the case of protected equipments an extra 4 dB will be allowed for receiver input level.
3 All measurements referenced to point C on the block diagram. (Fig 1.2).

3.6 Radiocommunications Agency will in general examine applications for the use of radio links on the assumption that the signal level of the receiver input is as outlined in Table 4.2 and a transmitter power shall be assigned accordingly. The levels in Table 4.2 are derived from a link budget as given in Annex A.

Maximum availabilities allowable are as follows:
99.999% to be agreed with RA on a case-by-case basis.
99.99% to be agreed with RA on a case-by-case basis.
99.9% for all other services.

3.7 The link budget shall include contributions from gaseous absorbtion and losses due to rain attenuation in addition to the free-space basic transmission loss. Gaseous absorbtion shall be based on oxygen and water vapour data obtained from CCIR Rep 719-2 Fig 3. The gaseous specific attenuation of 0.18 dB/km at a frequency of 29.5 GHz shall be assumed.

The fade margin M depends on path length and climatic rain zone. The United Kingdom is divided into four climatic rain zones, E,F,G and H shown in Fig 4.1, as defined by CCIR Rep 338-5 for an average year. Values of fade margin M for the climatic zones are shown in figures 4.2A to 4.2C for vertical polarisation for single section links, for 99.9%, 99.99% and 99.999% of time (average year).

The rain fade margin curves shown in Figs 4.2A to 4.2C are derived as follows:

(a) The rain intensity (R) for 0.1% of the time is obtained from CCIR Rep 563-3 Table 1, for the required rain climatic zone.

(b) The specific attenuation for the rain intensity (R) of interest is calculated for the required frequency and polarisation using Equation 1 of CCIR Rep 721-1:

$$y = k * R^{a}$$

Values of regression coefficients $k$ and $a$ are given in CCIR Rep 721-1. For a frequency of 29.5 GHz, on vertical polarisation the values assumed are;

$$k = 0.161$$
$$\text{and} \quad a = 1.003$$

(c) The path attenuation exceeded for 0.01% of time is given by Equation 17 of CCIR Rep 338-5

$$A_{0.01} = y * le = y * l * r$$
$$\text{where: } le \text{ (the effective path length)} = l * r$$

The path reduction term $r$ is given in CCIR Rep 338-5 as

$$r = \frac{1}{(1 + 0.045L)}$$

(d) The attenuation $Ap$ exceeded for other time percentages $p$ is deducted from equation 18 of CCIR Rep 338-5

$$Ap = A_{0.01} * 0.12 * p^{-(0.546 + 0.043 * \log_{10} p)}$$

3.8 Radiocommunications Agency will, as far as possible, assign frequencies on the basis that the estimated level of co-channel and adjacent channel interference for a single-entry interferer at the receiver input should not exceed the values of wanted-to-unwanted (w/u) signal ratios shown in Table 4.3 and 4.4. The ratios are given for an unwanted interferer when the wanted signal is at the reference sensitivity input level of Table 2.2. W/U ratios for single-entry interferers, for all digital and analogue systems (mixed capacities) are given in the matrices of Annex B for various channel separations.

3.9 The w/u ratios for co-channel interferers shown in Table 4.3 and Annex B have been derived on the assumption that a single unwanted interferer will be suppressed in the wanted channel to a level of -24 dB or -27 dB, relative to the reference sensitivity level and includes an allowance for multiple interferers.

The W/U ratios for adjacent channels in Table 4.4 and Annex B are based on the assumed adjacent channel filter protection factors of 27 dB for 2 Mbit/s systems and 24 dB for other bit rates, given in Table 4.4, and also includes allowances for multiple interferers.

3.10 In Tables 4.3 and 4.4 and Annex B, the W/U ratios assume allowances for multiple interferers which are dependant on bit rate and the expected density of links. The allowances are 6 dB (based on four equal level interferers) at the lower bit rates and 3 dB (based on two equal level interferers) at the other bit rates.